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(54) **PIPE LINING SYSTEMS AND METHODS OF USE**

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(51) **Int. Cl.**

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F16L 55/179	(2006.01)
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F16L 55/1645	(2006.01)

(52) **U.S. Cl.**

CPC ***F16L 55/1654*** (2013.01); ***F16L 55/179*** (2013.01); *F16L 55/163* (2013.01); *F16L 55/16455* (2013.01); *F16L 55/1651* (2013.01); *F16L 55/1656* (2013.01)

(58) **Field of Classification Search**

CPC ... F16L 55/1654; F16L 55/179; F16L 55/163; F16L 55/16455; F16L 55/1651; F16L 55/1656

USPC 138/97, 98; 405/150.1, 184.2

See application file for complete search history.

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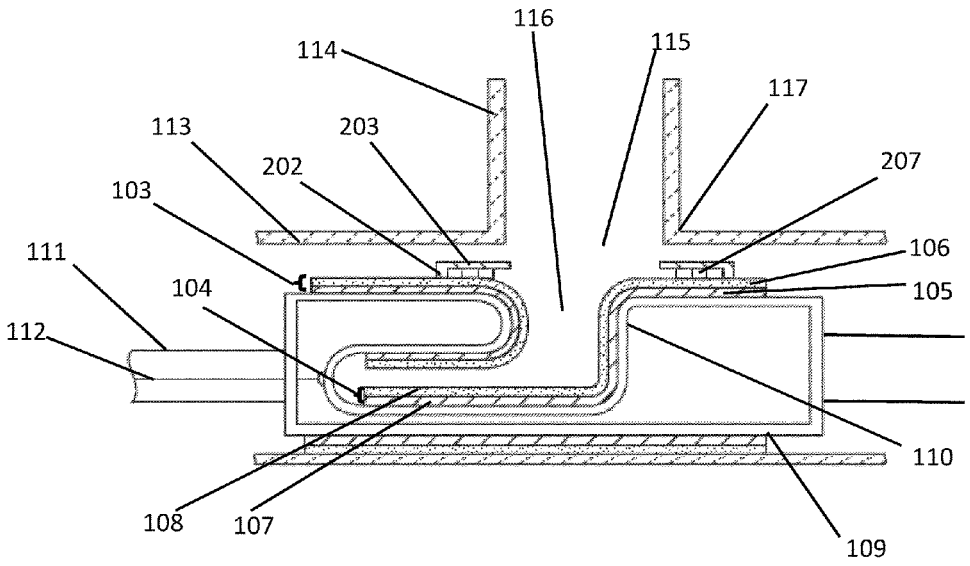
(57) **ABSTRACT**

Systems and methods for pipe lining systems and methods of use are described. Systems and methods may include a CIPP lateral liner that is inserted into a bladder forming a CIPP liner assembly that can be inserted into a pipe line for a pipe repair. CIPP liner assembly can include a membrane that produces superior results compared to the prior art. A backing ring may be used with these systems and methods.

20 Claims, 12 Drawing Sheets



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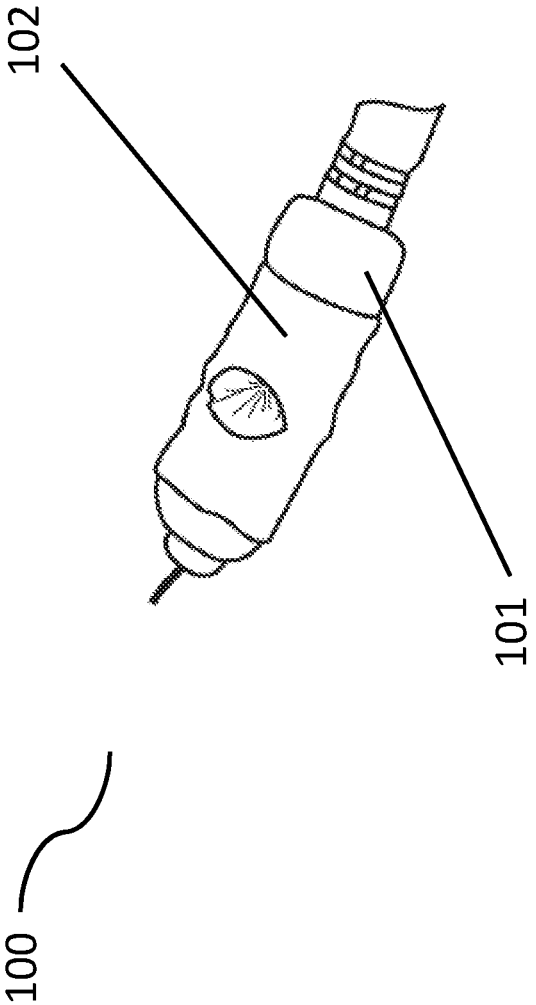


Fig. 1

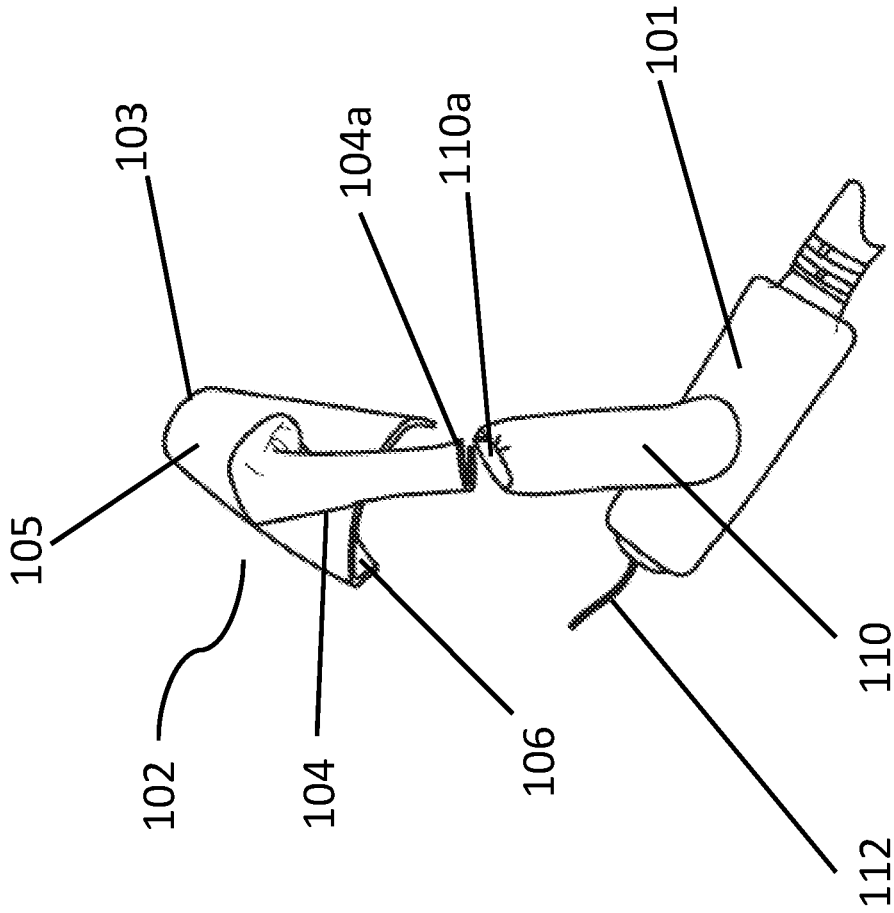


Fig. 2

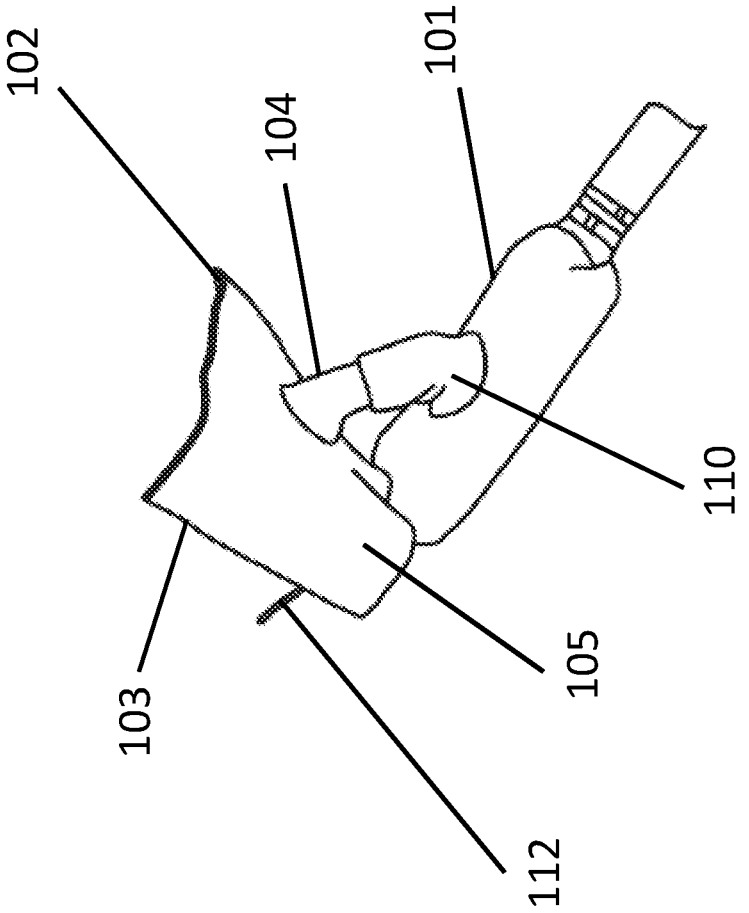


Fig. 3

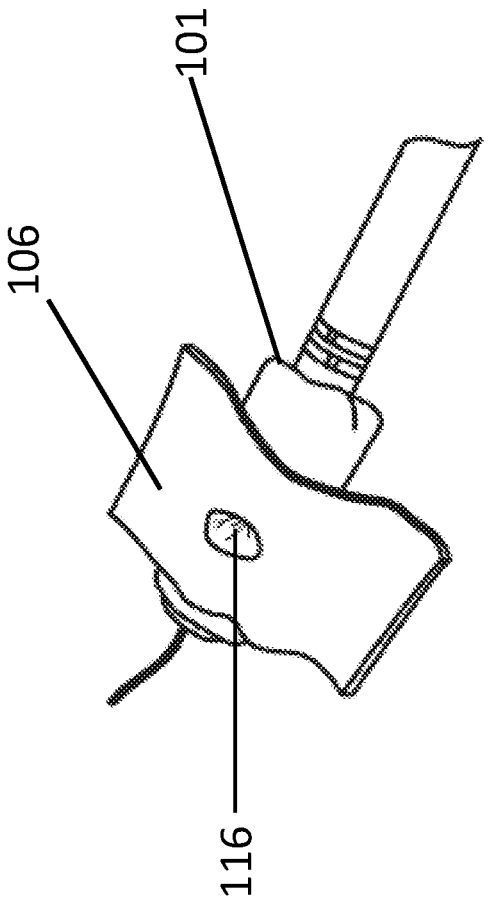


Fig. 4

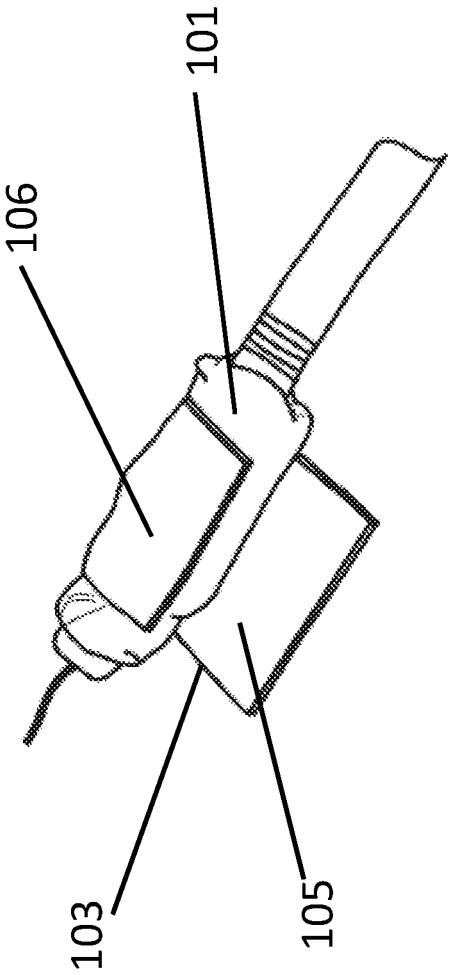
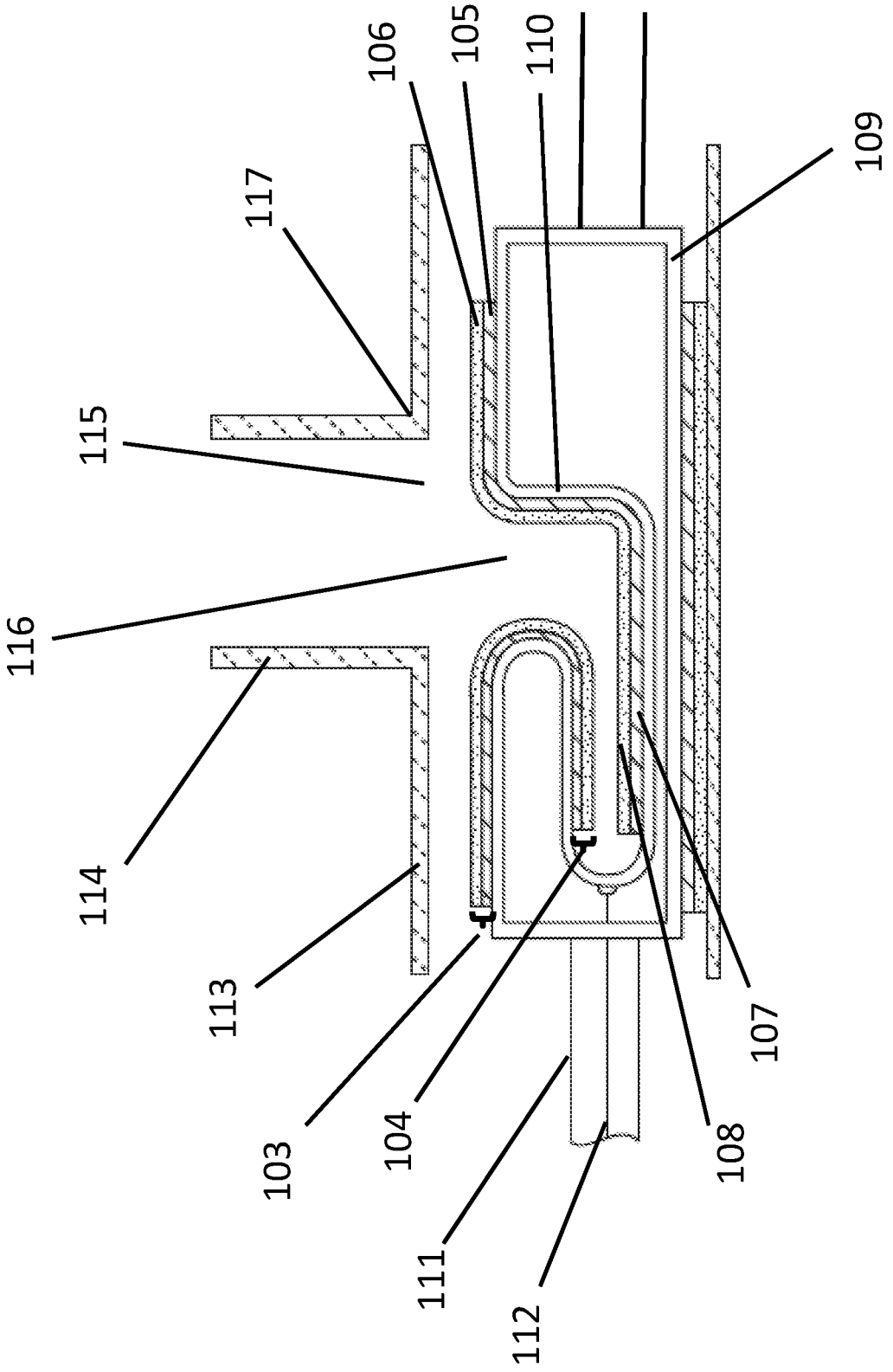


Fig. 5



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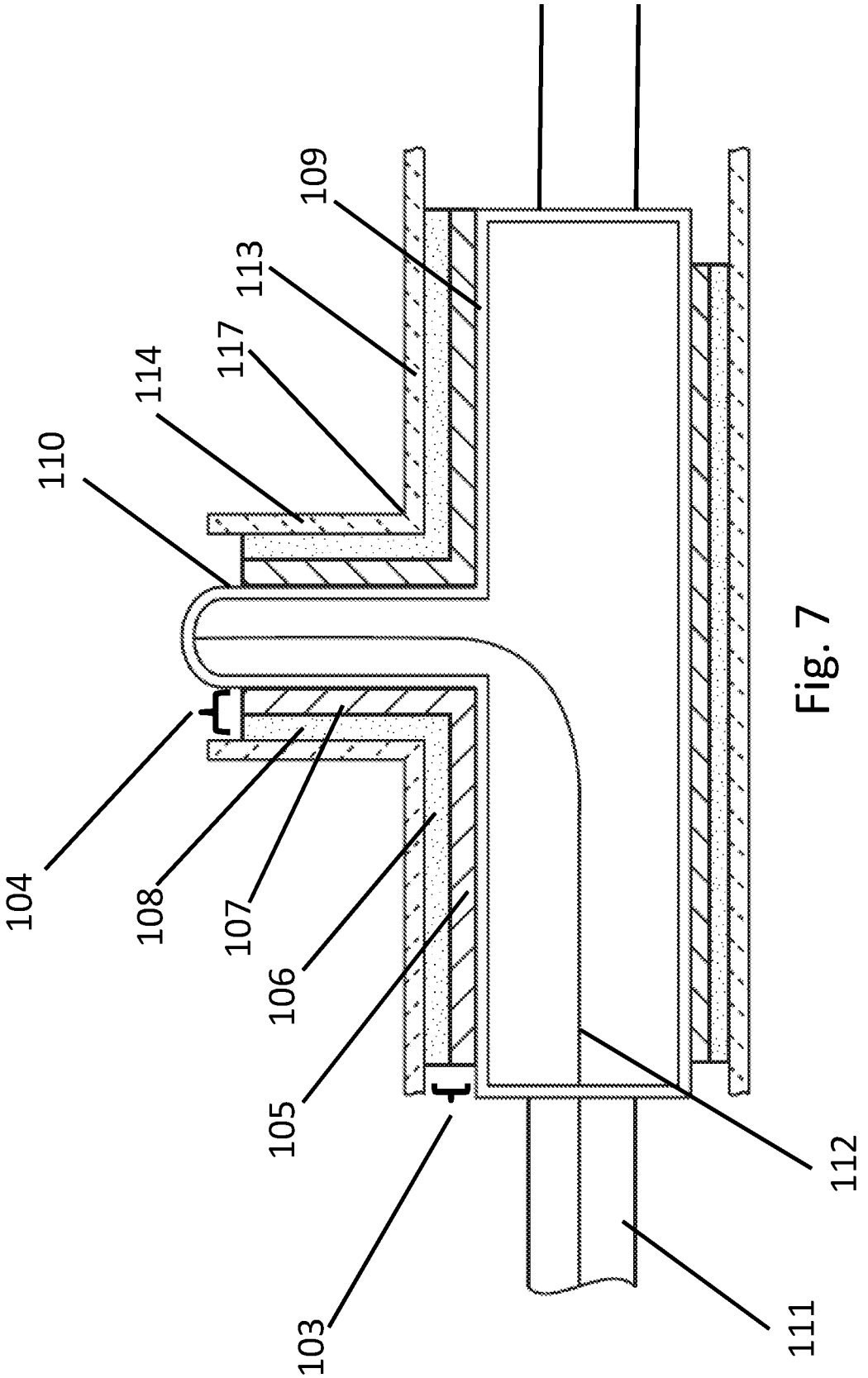

Fig. 7

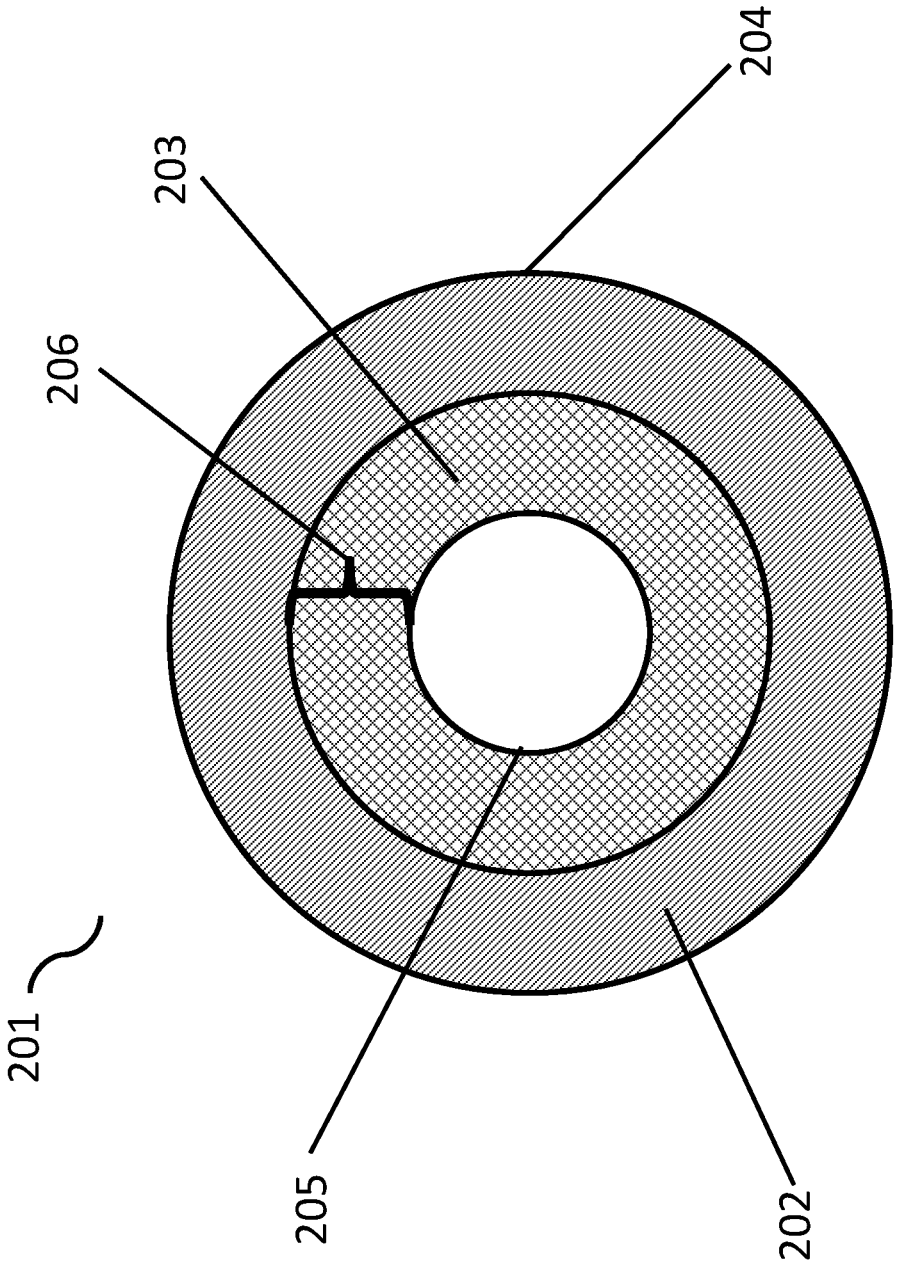

Fig. 8

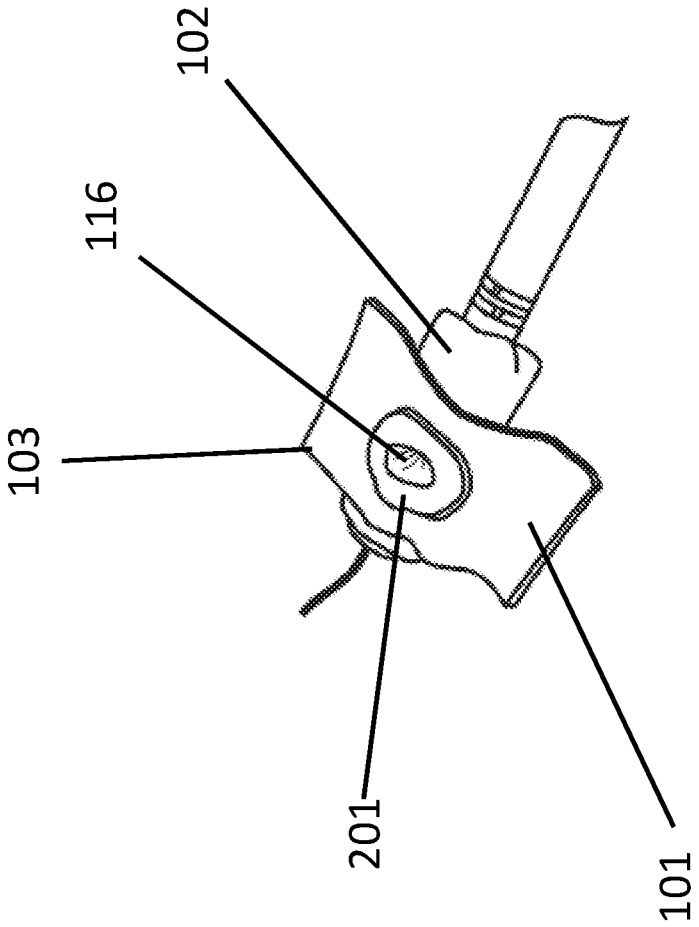

Fig. 9

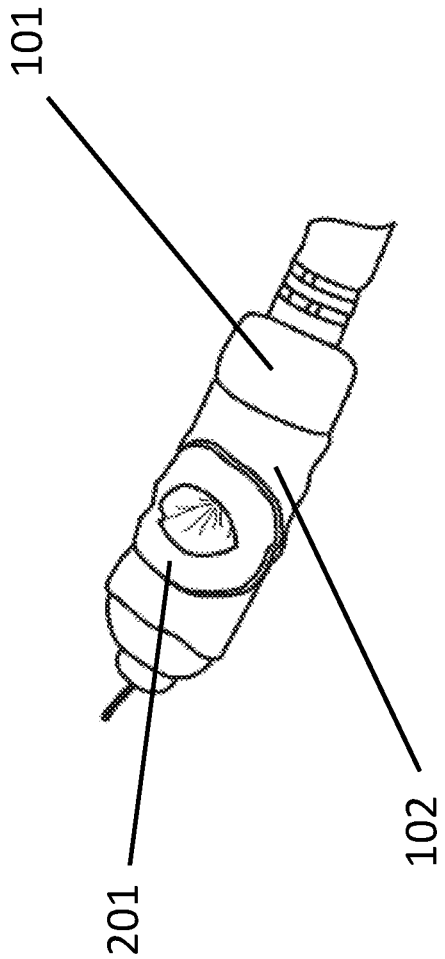

Fig. 10

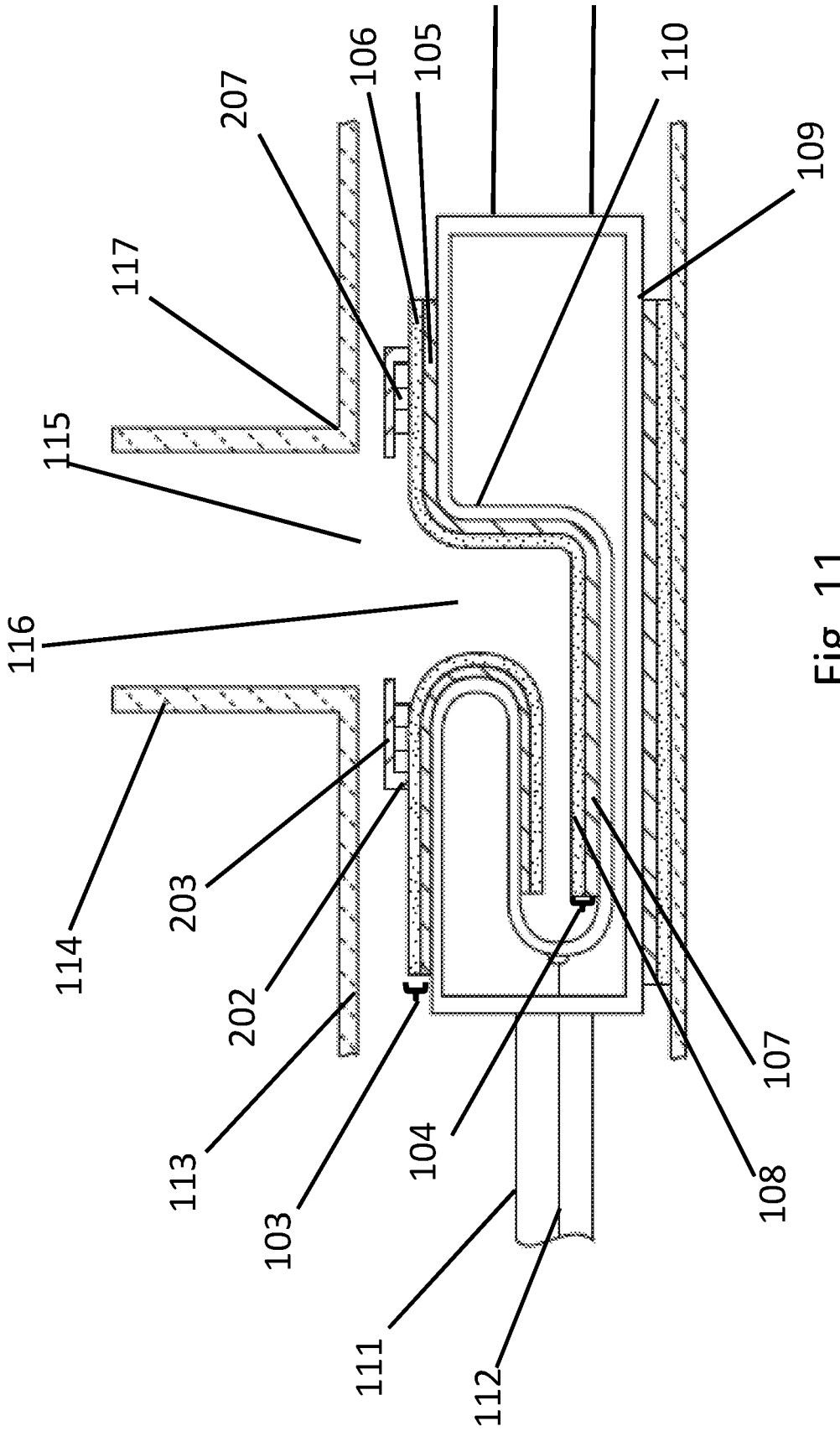
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Fig. 11

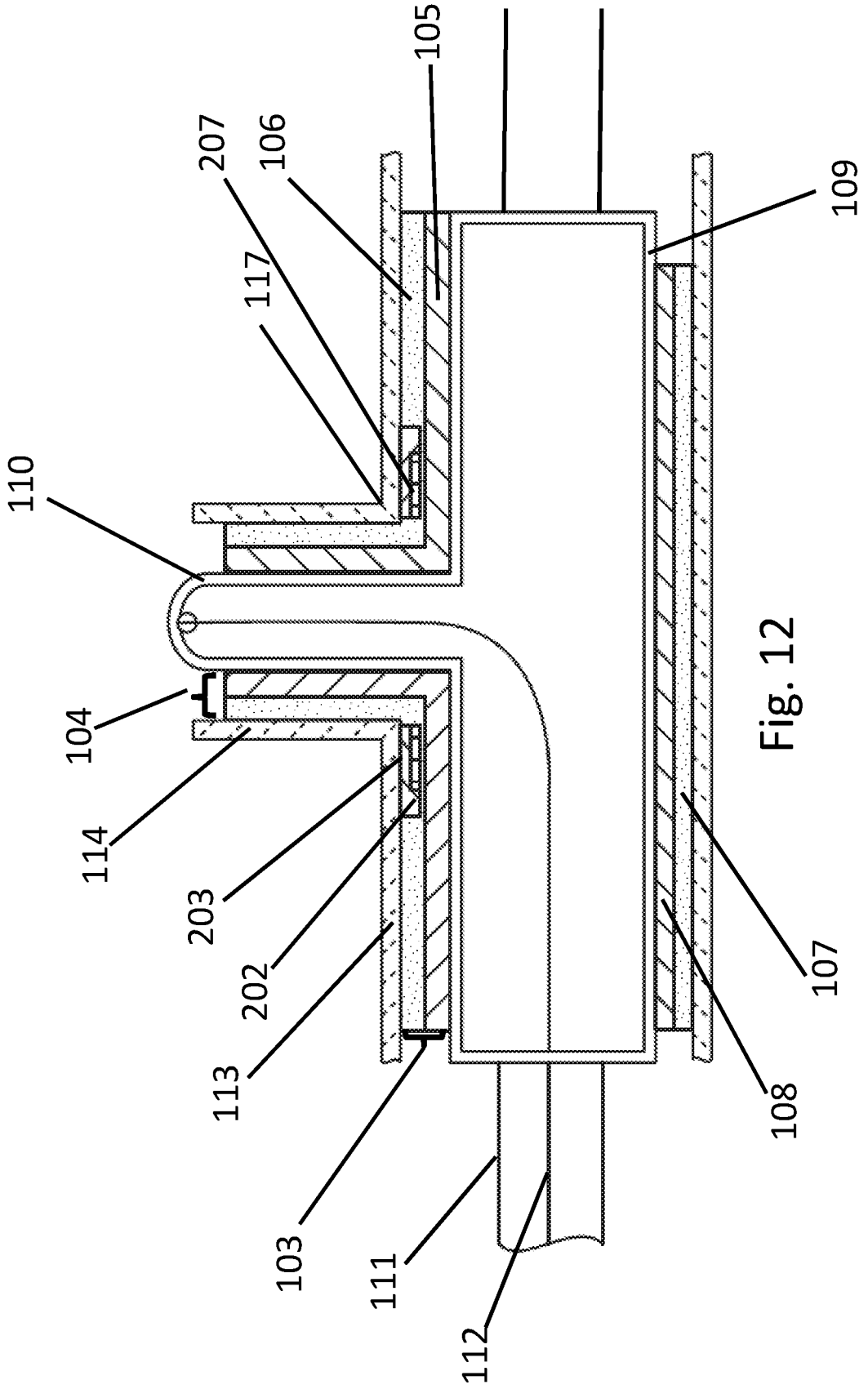

Fig. 12

PIPE LINING SYSTEMS AND METHODS OF USE

INCORPORATION BY REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 17/014,052, filed Sep. 8, 2020, which is a continuation of U.S. application Ser. No. 15/663,549, filed Jul. 28, 2017, granted as U.S. Pat. No. 10,767,805, which claims priority to U.S. Provisional Application No. 62/367,941 filed Jul. 28, 2016, the contents of which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

The present invention relates to systems and methods for a pipe lining system, methods of making a pipe lining system, and methods of using a pipe lining system.

BACKGROUND OF THE INVENTION

Needs exist for improved systems and methods for repairing pipes, including underground sewer pipes. Underground pipes can leak or become susceptible to inflow and infiltration ("I/I") for a number of reasons. Junctures where lateral pipe lines meet or branch from main line pipes are one area that can require unique repair methods.

Lateral pipe lines are often the pipes that lead from a main pipe line to smaller pipes or homes. For example, main pipe lines often run generally horizontally relative to the ground and a lateral pipe line is installed at some upward angle off of the main pipe line. A lateral pipe line may be positioned at 90 degrees relative to a main pipe, i.e., a "T", or an angle less than 90 degrees, i.e., a "Y". At times, lateral pipe lines are installed after main pipe lines have been installed and the juncture may have never been properly sealed.

In some situations, a hole may be required in a main pipe line, e.g., for a lateral pipe line to be inserted or connected to the main pipe line. This may allow for I/I from the moment the lateral pipe line is installed. Even for lateral pipe lines initially installed correctly, problems can arise over time that damage or weaken the juncture allowing for I/I. The surrounding earth may shift, plant roots may infiltrate the juncture, or flexural problems such as those from cars passing over underground pipes, may arise and cause I/I at the juncture.

Prior art devices and methods have attempted to solve this problem using various cured-in-place pipe (CIPP) repairs devices but have not done so successfully. Some prior art methods rely on a "T" or "Y" shaped liner that is inserted in the main pipe line and lateral pipe line to repair the damaged juncture. These devices and methods, however, have not achieved sufficient results. Moreover, positioning the repair device in the pipe so that it can be positioned in the correct location underground can be time consuming and difficult, especially once a liner is saturated in resin. A prior art example is described in U.S. Pat. No. 6,039,079, which is incorporated by reference in its entirety, but the examples of that disclosure do not adequately solve the problems solved by the devices and methods described herein, such as inter alia, providing improved adherence to a host pipe. Another prior art example that did not solve the problems solved by the devices and methods described herein is U.S. Pat. No. 7,503,349, which is incorporated by reference in its entirety.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate preferred embodiments of the invention and together with the detailed description serve to explain the principles of the invention. In the drawings:

FIG. **1** shows one CIPP liner of embodiments of the present invention positioned on a bladder.

FIG. **2** shows a view of a CIPP liner of embodiments of the present invention as it is being inserted into a bladder.

FIG. **3** shows another view of one CIPP liner of embodiments of the present invention as it is being inserted into a bladder.

FIG. **4** shows a view of one CIPP liner of embodiments of the present invention showing a main line liner before it is wrapped around a bladder.

FIG. **5** shows a view of one CIPP liner of embodiments of the present invention with a main line liner as it is wrapped around a bladder.

FIG. **6** shows a sectional view of a CIPP liner of embodiments of the present invention with a main line liner after it has been inserted into a bladder and the assembly has been inserted into a pipe line.

FIG. **7** shows a sectional view of one CIPP liner with a main line liner after a CIPP lateral liner has been inverted into a lateral pipe line.

FIG. **8** shows a backing ring useful in certain embodiments.

FIG. **9** shows one positioning of a backing ring on a CIPP liner of embodiments of the present invention on a bladder prior to a main line liner being wrapped around the bladder.

FIG. **10** shows one positioning of a backing ring on a CIPP liner of embodiments of the present invention prior to installation into a pipe line.

FIG. **11** shows a sectional view of one CIPP liner of embodiments of the present invention containing a backing ring positioned for repair of a lateral pipe line.

FIG. **12** shows a sectional view of one CIPP liner of embodiments of the present invention after being inverted into a lateral pipe line.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The examples described herein relate to pipe lining systems and methods of use. These examples are for illustrative purposes only.

An embodiment of the invention is an apparatus comprising: a CIPP liner assembly comprising a main line liner and a CIPP lateral liner; a bladder comprising a main liner bladder and a lateral installation bladder; wherein said main line liner comprises a felt layer and a membrane; wherein said CIPP lateral liner comprises a CIPP lateral liner felt layer and a CIPP lateral liner membrane; wherein said felt layer is positioned so that it is contacting said main line liner; wherein said CIPP lateral liner is positioned inside of said lateral installation bladder and said CIPP lateral liner and said lateral installation bladder are positioned inside of said main liner bladder; and said CIPP lateral liner membrane is positioned so that it is contacting said lateral installation bladder.

A method of the invention is a method of positioning a CIPP liner on a bladder, the steps comprising: providing a CIPP liner wherein said CIPP liner comprises a main line liner and a CIPP lateral liner and the CIPP lateral liner is attached to said main line liner, forming a T-shape; providing a bladder wherein said bladder comprises a main liner bladder and a lateral installation bladder and said lateral installation bladder is attached to said main liner bladder,

forming a T-shape; forming a U-shape with a first end of said CIPP lateral liner; inserting said U-shaped first end of said CIPP lateral liner into a first end of a lateral installation bladder so that a CIPP lateral liner membrane faces an inner diameter of said lateral installation bladder; positioning said CIPP lateral liner and said lateral installation bladder inside of said main liner bladder; wrapping said main line liner comprising a felt layer and a membrane around said main liner bladder so that said membrane is facing an outer diameter of said main liner bladder; and securing said main line liner to said bladder.

Another embodiment of the invention is a backing ring comprising: an inward facing portion and an outward facing portion a first edge portion around an outer circumference of said backing ring, and a second edge portion around in inner circumference of said backing ring; an edge portion around a circumference of said backing ring; and said backing ring comprises a felt.

An embodiment of the invention is an apparatus, comprising: a CIPP liner; a backing ring comprising: an inward-facing portion, an outward-facing portion, a first edge portion around an outer circumference of said backing ring, and a second edge portion around an inner circumference of said backing ring; wherein said inward-facing portion is attached to said CIPP liner; said backing ring further comprises a bonded portion and an unbonded portion, wherein said unbonded portion comprises a pocket; and said backing ring is positioned on or around a lateral opening of said CIPP liner.

One method of the invention is a method of repairing a lateral junction of a pipe, the method comprising: providing a CIPP liner; providing a backing ring comprising: an inward-facing portion, an outward-facing portion, a first edge portion around an outer circumference of said backing ring, and a second edge portion around an inner circumference of said backing ring; wherein said backing ring is attached to said CIPP liner with said inward facing portion toward said CIPP liner; positioned on or around a lateral opening of said CIPP liner; bonding a portion of said backing ring to said CIPP liner; and forming an unbonded portion of said backing ring comprising a pocket.

Certain embodiments may comprise everting a lateral pipe liner into a lateral pipe and compressing said hydrophilic material between said cured-in-place pipe liner and said backing ring while pressing said outward-facing portion of said backing ring against the inside of a pipe.

Certain embodiments may comprise everting a lateral pipe liner into a lateral pipe and compressing said hydrophilic material between said cured-in-place pipe liner and said backing ring while pressing said outward-facing portion of said backing ring against a juncture of a main pipe and a lateral pipe.

Certain embodiments may comprise a method of positioning a cured-in-place (CIPP) liner on a bladder, the steps comprising: providing a CIPP liner wherein said CIPP liner comprises a main line liner and a CIPP lateral liner and the CIPP lateral liner is attached to said main line liner, forming a T-shape; providing a bladder wherein said bladder comprises a main liner bladder and a lateral installation bladder and said lateral installation bladder is attached to said main liner bladder, forming a T-shape; forming a U-shape with a first end of said CIPP lateral liner; inserting said U-shaped first end of said CIPP lateral liner into a first end of a lateral installation bladder so that a CIPP lateral liner membrane faces an inner diameter of said lateral installation bladder; positioning said CIPP lateral liner and said lateral installation liner inside of said main liner bladder; wrapping said main line liner comprising a felt layer and a membrane around said main liner bladder so that said membrane is facing an outer diameter of said main liner bladder; and securing said main line liner to said bladder.

FIG. **1** shows CIPP liner assembly **100** positioned on bladder **101** where CIPP liner assembly **100** is ready to be inserted into a pipe line for a repair. CIPP liner **102** can comprise a felt material, a needled felt material, a polyester, a glass material, a knit material and mixtures thereof. In certain embodiments, a felt layer may comprise a felt material comprising a fiberglass. As used herein, the terms "felt" and "felt layer" can be used to refer to any one of or combination of these materials and the meaning will be clear to the ordinarily skilled artisan when considering the context in which the term is used.

In certain embodiments, CIPP liner **102** comprises membrane **105** on a side of CIPP liner **102** as seen in FIG. **2**.

CIPP liner **102** can be impregnated with resin prior to attaching CIPP liner **102** to bladder **101**. When impregnating CIPP liner **102** with resin, felt layer **106** of CIPP liner **102** can be impregnated with resin. Membrane **105** can allow for a vacuum to be applied to CIPP liner **102** by acting as a layer that is impermeable to air. A vacuum can be applied using a pump. A vacuum can be applied to CIPP lateral liner **104** and can be applied when membrane **105** is facing outward and felt layer **106** is facing inward. Resin can then be applied to the inward-facing felt layer of CIPP liner **102**. Membrane **105** can be transparent or translucent to allow felt layer **106** of CIPP liner **102** to be visible through membrane **105**, which can allow for visible inspection of resin saturation in the felt layer during and after resin impregnation.

In certain embodiments, membrane **105** can be opaque. In some embodiments, membrane **105** can comprise a material that changes color when it comes into contact with a liquid, such as water or a resin. In certain embodiment, felt layer **106** can comprise a material that changes color when it comes into contact with a liquid, such as water or a resin.

In certain embodiments, CIPP lateral liner **104**, as seen in FIG. **2**, can be tubular in shape and felt layer **106** forms an inner circumference of CIPP lateral liner **104** and membrane **105** forms an outer circumference of CIPP lateral liner **104**.

Applying a vacuum to CIPP liner **102** can allow for efficient and improved saturation of felt layer **106** of CIPP liner **102**. Improved saturation and penetration of resin into felt layer **106** produces superior results when a liner is installed into a pipe line because it allows for greater strength and resiliency once CIPP liner **102** is cured. By positioning membrane **105** so that it faces outward and felt layer **106** faces inward, a vacuum can be applied to CIPP liner **102** without the use of a bag or other additional sealing material that is used as an air-tight barrier to form a vacuum. CIPP liner **102**, as disclosed herein, can have a vacuum applied to CIPP liner **102** using a pump connected directly to the CIPP liner **102**. In some embodiments, a CIPP Liner **102** can be folded so that folding can cause contact between a first folded edge and a second folded edge. In some embodiments these edges can be sealed when applying a vacuum to a CIPP liner **102**, allowing for improved resin saturation.

A pump can be attached to CIPP lateral liner **104** and or CIPP liner **102**, at a port, hole, or the like formed in CIPP liner **102** and/or CIPP lateral liner **104**. A hose or the like can be attached to the port, hole, or the like to form an air connection between a pump and CIPP lateral liner **104**. Upon activating the pump, a vacuum can be applied to the inside of CIPP lateral liner **104**. By removing the air from inside CIPP lateral liner **104**, resin can more thoroughly

penetrate and saturate CIPP lateral liner felt layer **108**. Applying a vacuum to a CIPP lateral liner **104** while the CIPP lateral liner membrane **107** is facing outward and CIPP lateral liner felt layer **108** is facing inward and subjected to a vacuum allows for the unexpectedly superior results of achieving a better vacuum than has been achieved in the past and also allows for improved resin impregnation resulting in improved pipe repairs. When applying a vacuum, a membrane can be advantageously positioned so that a felt layer **106** faces inward while membrane **105** faces outward, producing the unexpectedly superior results of improving a vacuum, which can improve resin impregnation.

Membrane **105** can be polyurethane, polypropylene, polyethylene, and the like, and combinations thereof. In some embodiments, membrane **105** and/or CIPP lateral liner membrane **107** can be transparent, translucent, or opaque. In some embodiments, membrane **105** and/or CIPP lateral liner membrane **107** can be permeable, semi-permeable, or impermeable to air and liquids. In certain embodiments CIPP liner **102** may be cured using steam or water. In certain embodiments, a CIPP liner may be cured using ambient temperatures. Membrane **105** can comprise a polymer. Membrane **105** can be applied to CIPP liner **102** before or during its manufacture and/or can be applied at a job site.

FIG. **2** shows CIPP liner **102** and bladder **101** where CIPP liner **102** comprises a main line liner **103** and a CIPP lateral liner **104**. Main line liner **103** can comprise membrane **105** and felt layer **106**. Main line liner **103** can be a flat sheet as shown in FIG. **2**.

CIPP liner **102** can be impregnated with a resin, epoxy, or the like, which allows CIPP liner **102** to harden after it is installed into a pipe line. As used herein, the term "resin" can refer to resin and/or epoxy and the usage will be clear to the ordinarily skilled artisan when considering the context. CIPP liner **102** can be cured using a curing medium such as hot water, hot air, steam, or the like. CIPP liner **102** can be cured by directing a curing medium to bladder **101** that has CIPP liner **102** positioned on it, thus initiating the curing reaction that can cause CIPP liner **102** to harden.

In certain embodiments, main line liner **103** can be disk-shaped and form a brim-shape when attached to CIPP lateral liner **104**. A brim-shaped portion of main line liner **103** can be positioned in a host pipe so that a brim portion of main line liner **103** is positioned within a main pipe while CIPP lateral liner **104** is positioned in a lateral pipe. A brim-shaped portion can be positioned so that it is flush against the inside of a main line pipe after CIPP liner **102** has been inserted into a pipe line and CIPP liner **102** envelopes the juncture between the main line pipe and the lateral pipe, and the lateral portion of CIPP liner **102** lines the inside of the lateral pipe.

Referring to FIGS. **2-7**, CIPP lateral liner **104** can comprise CIPP lateral liner membrane **107** and CIPP lateral liner felt layer **108**. Bladder **101** can comprise main liner bladder **109** and lateral installation bladder **110**. Bladder **101** can comprise layflat hose **111**. Bladder **101** can comprise pull-in cable **112**.

FIG. **2** shows first end **104***a* of CIPP lateral liner **104** can be folded into a shape, such as a U-shape, prior to inserting first end **104***a* of CIPP lateral liner **104** into first end **110***a* of lateral installation bladder **110**. Lateral installation bladder **110** can be slightly cupped at first end **110***a* so that first end **104***a* of CIPP lateral liner **104** can be inserted therein. CIPP lateral liner **104** can be inserted so that CIPP lateral liner membrane **107** is directly contacting an inner diameter of lateral installation bladder **110**. Folding first end **104***a* of CIPP lateral liner **104** into a shape, such as a U-shape, can allow CIPP lateral liner **104** to fit in first end **110***a* of lateral installation bladder **110** and provide for friction when lateral installation bladder **110** is pulled into main line bladder **109**. Pull-in cable **112** can be used to pull CIPP lateral liner **104** and lateral installation bladder **110** into bladder **101**. CIPP lateral liner **104** along with corresponding lateral installation bladder **110** can be pulled inside of main line bladder **109** so that the entire assembly can be moved through and positioned in a damaged pipe line.

FIG. **3** shows CIPP liner **102** as it is inserted into bladder **101**. CIPP lateral liner **104** can be inserted into lateral installation bladder **110** until a membrane **105** of main line liner **103** is flush with main liner bladder **109** once the full length of CIPP lateral liner **104** is inserted into lateral installation bladder **110**.

In some embodiments, CIPP lateral liner **104** is not inserted into lateral installation bladder **110**, which can allow for CIPP liner **100** to be used in pull-in-place installations. When using an embodiment with a pull-in-place installation, CIPP lateral liner **104** may not be pulled inside of bladder **101** and when installing CIPP liner **102** into a pipe, CIPP lateral liner **104** can be pulled into a lateral pipe line and then a lateral installation bladder **110** can be inflated, being inserted into CIPP lateral liner **104**. CIPP liner **102** can be cured as described herein once it has been positioned using a pull-in-place installation.

FIG. **4** shows main line liner **103** once it is flush with main liner bladder **109** and the full length of CIPP lateral liner **104** has been inserted into lateral installation bladder **110**, and both CIPP lateral liner **104** and lateral installation bladder **110** are inside main liner bladder **109**. Liner opening **116** is shown prior to insertion of CIPP liner assembly **100** into a damaged pipe line and liner opening **116** can be aligned with the juncture once CIPP liner assembly **100** is inserted into a pipe line. Lateral installation bladder **110** and CIPP lateral liner **104** may be positioned within bladder **101** until lateral installation bladder **110** is inverted inside a lateral pipe to be repaired.

FIG. **5** shows main line liner **103** as it is wrapped around a bladder **101** so that the ends of main line liner **103** can overlap. The ends of main line liner **103** may overlap at a distance configured to allow edges of main liner **103** to overlap and expand to main line pipe without separating and/or leaving a gap between main liner **103** edges when CIPP liner **102** is inflated during installation. In certain embodiments, overlap of edges of main line liner **103** may be between about 1-3 inches, about 1-5 inches, about 1-10 inches, and ranges therebetween depending on the specifications determined for that specific repair. Main line liner **103** can then be held in place on main liner bladder **109** using any suitable securing device, for example, rubber bands, o-rings including but not limited to hydrophilic o-rings, elastic bands, twist-ties, zip-ties and the like. In certain embodiments, a securing device is configured so that it has a tensile strength designed to break once bladder **101** is inflated during installation of CIPP liner **102**. Main line liner **103** can be secured around bladder **101** so that membrane **105** is directly contacting bladder **101** with felt layer **106** facing outward toward the inner diameter of main pipe line **113**.

CIPP liner assembly **100** can then be inserted into a pipe line to be repaired as shown in FIG. **6**. A pipe line to be repaired can comprise main pipe line **113** and lateral pipe line **114**. CIPP liner assembly **100** can be positioned so that liner opening **116** is aligned with lateral pipe line **114**. By positioning liner opening **116** beneath lateral pipe line **114** and aligning liner opening **116** with lateral opening **115**,

lateral installation bladder **110** and CIPP lateral liner **104** can be inverted into lateral pipe line **114** as shown in FIG. **7**. This can be done when bladder **101** is filled with air, steam, water, or the like, to cure the CIPP lateral liner **104** and main line liner **103** to repair and seal juncture **117**.

CIPP liner assembly **100** can be positioned using a closed-circuit television (CCTV) camera that is inserted into a pipe line prior to inserting CIPP liner assembly **100**. This way, a repair can be properly assessed, allowing proper positioning and sizing of repair materials.

After bladder **101** is inflated, CIPP lateral liner **104** can be fully extended into lateral pipe line **114** after being inverted as is shown in FIG. **7**. Bladder **101** can be filled with water, steam, or the like to heat a resin, which has been impregnated into CIPP lateral liner **104** and main line liner **103**. Heating a resin as described can cause the resin to cure and harden. A resin can also be cured at ambient temperature. After main line liner **103** and CIPP lateral liner **104** have hardened, bladder **101** can be de-inverted out of CIPP lateral liner **104**, which can be performed by pulling pull-in cable **112**, causing lateral installation bladder **110** to be pulled out of lateral pipe line **114** into main liner bladder **109**, which can allow for bladder **101** to be removed from a host pipe line while the main line liner **103** and CIPP lateral liner **104** remain in place.

By inserting CIPP liner **102** so that membrane **105** and CIPP lateral liner membrane **107** directly contact bladder **101**, unexpectedly superior results can be produced because installed CIPP liner **102** as described herein can have a resin saturated felt layer **106** positioned against a pipe line wall so that a resin saturated felt layer can directly contact a pipe line inner wall, which can also allow resin to enter cracks, openings, or other defects in a pipe line inner wall, which can result in a locking effect that adheres CIPP liner **102** to a pipe line and improves the reliability and strength of an installed CIPP liner. By positioning a cured CIPP liner so that its membrane faces the inside of a pipe line, flow disturbances caused by, e.g. water, are unexpectedly diminished, reducing the coefficient of friction resulting in unexpectedly enhanced flow characteristics of the repaired pipe line and an unexpectedly superior pipe repair. Positioning a CIPP liner so that a membrane makes contact with a bladder, can produce the unexpectedly superior results of extending the lifetime of a bladder because this arrangement can reduce or eliminate resin contacting the bladder. Contact with resin can cause a bladder to deteriorate or experience diminished lifespan. In some embodiments a bladder does not comprise a coating. A bladder may also comprise a coating that can allow a membrane to easily release from a bladder during installation. In some embodiments, a coating can be an oil, a silicone, a lubricant, a dish detergent, a gel, a protective liquid, a powder, a mold release, a grease, or any other suitable coating.

In certain embodiments, a CIPP liner assembly can also comprise a backing ring. FIG. **8** shows an example of a backing ring **201**. Backing ring **201** can comprise bonded portion **202** and unbonded portion **203**. Backing ring **201** can comprise outer diameter **204** and inner diameter **205**. Unbonded portion **203** can form pocket **206**, in which a hydrophilic material can be positioned and/or inserted.

FIG. **9** shows one embodiment of positioning backing ring **201** on a CIPP liner assembly **100** prior to insertion and installation into a pipe line as shown in FIG. **11**.

FIG. **9** also shows main line liner **103** and CIPP lateral liner **104** positioned in bladder **101**. Backing ring **201**, can be positioned on or around lateral opening **115**. CIPP lateral liner **104** can be attached to main line liner **103**. Backing ring **201** can be positioned on main line liner **103** so that a downward facing side is directly contacting a main line liner **103**. Backing ring **201** can be attached by bonding a portion of backing ring **201** to main line liner **103** forming bonded portion **202** as was shown in FIG. **8**. In certain embodiments, backing ring **201** can be bonded to felt layer **106** of main line liner **103**. In certain embodiments, backing ring **201** can be directly bonded to felt layer **106** of CIPP liner **102**. In certain embodiments, backing ring **201** can be bonded to membrane **105**. In certain embodiments, backing ring **201** can be bonded directly to membrane **105** and/or CIPP lateral liner membrane **107**. Backing ring **201** comprising a bonded portion can comprise an unbonded portion **203**. In certain embodiments, unbonded portion **203** comprises pocket **206** that can also comprise a hydrophilic material.

In certain embodiments, CIPP liner assembly **100** may comprise a hydrophilic material. Hydrophilic material can be positioned at or near lateral opening **115** once a CIPP liner assembly **100** with backing ring **201** is positioned in a pipe line. A hydrophilic material can be a paste, liquid, gel, caulk, mastic, any combination thereof, a pre-formed shape comprised of any of these and combinations of these, and the like. An example of such a material is ULTRASEAL commercially available from OCM/ADEKA USA CORPORATION. In some embodiments, the hydrophilic material can swell when it is contact with water. In certain embodiments, CIPP liner assembly **100** may comprise backing ring **201** and hydrophilic material. In certain embodiments, a hydrophilic material may be substituted with a hydrophobic material, such as wax, hydrophobic rubber, hydrophobic paste, hydrophobic gel, and the like.

In certain embodiments, half of a surface area of backing ring **201** can be bonded to CIPP liner **102**. In certain other embodiments, less than half of a surface area of backing ring **201** can be bonded to CIPP liner **102**. A backing ring **201** can be configured so that it covers a portion of main line liner **103**, which can cover a pre-determined area of main line liner **103** and retain a hydrophilic material and cover a portion of a juncture to allow for adequate retention of hydrophilic material. Backing ring **201** can have inner and outer diameters that are sized to achieve this desired coverage. Depending on the specifications, a bonded surface area of backing ring **201** can be between about 5-10%, 5-20%, 5-20%, 5-30%, 5-40%, 5-50%, 5-60%, 5-70%, 5-80%, 65-85%, 60-90%, and ranges therebetween. In certain embodiments, backing ring can be positioned so that a portion of backing ring **201** overhangs liner opening **116**. Backing ring **201** can be positioned so that backing ring **201** contacts CIPP lateral liner **104** and main line liner **103** after CIPP lateral liner **104** has been inverted into lateral pipe line **114**. When backing ring **201** is used in this way, it can be positioned so that a first portion of backing ring **201** is contacting main line liner **103** and a second portion is contacting CIPP lateral liner **104**.

In certain embodiments backing ring **201** can comprise an unbonded portion. In certain embodiments an unbonded surface area of a backing ring can be between about 1-10%, 1-20%, 10-20% 5-20%, 5-30%, 5-40%, 5-50%, 5-60%, 5-70%, 5-80%, 15-35%, and ranges therebetween.

FIG. **10** shows an embodiment where backing ring **201** is positioned on CIPP liner **102** that is positioned on a bladder **101** as described herein.

FIG. **11** shows an embodiment where CIPP liner assembly **100** comprises backing ring **201** that is positioned inside of a pipe line to be repaired. A pipe line to be repaired can comprise a main pipe line **113** and a lateral pipe line **114**. CIPP liner assembly **100** is positioned so that liner opening

116 is aligned with lateral opening 115 of lateral pipe line 114. By positioning liner opening 116 beneath lateral pipe line 114 and aligning it with lateral opening 115, lateral installation bladder 110 and CIPP lateral liner 104 can be inverted into lateral pipe line 114 as shown in FIG. 12 when bladder 101 is filled with air, steam, water, or the like.

FIG. 12 shows positioning of backing ring 201 on main line liner 103 after CIPP lateral liner 104 has been inverted into lateral pipe line 114. During inversion, CIPP lateral liner 104 is positioned within lateral pipe line 114, and CIPP liner 102 can seal juncture 117 and position backing ring 201 at or near juncture 117. Backing ring 201 can be positioned so that pocket 206 is formed between the edge of an inner diameter 205 of backing ring 201 and inverted CIPP lateral liner 204. Pocket 206 can allow hydrophilic material 207 to interact with any water that enters the pipe line, causing the hydrophilic material 207 to swell and seal the pipe line at juncture 117 or thereabout.

In certain embodiments, backing ring 201 can have an inner diameter 205 that is approximately equal, or slightly smaller to the diameter of lateral opening 115, which can be approximately equal to an outer diameter of liner opening 116 of CIPP lateral liner 104. An edge of an inner diameter of backing ring 201 can be flush with CIPP lateral liner 104 after inversion, thus positioning hydrophilic material 207 between main line liner 103 and backing ring 201. Backing ring 201 can be compressed against the inner diameter of main pipe line 113 and/or lateral pipe line 114. In certain embodiments, hydrophilic material 207 cannot make direct contact with a pipe line. In certain embodiments, hydrophilic material 207 can interact with water that enters a pipe line when the hydrophilic material 207 is held between main line liner 103, CIPP lateral liner 104, and backing ring 201. Backing ring 201 can be resin-saturated or not resin-saturated. Backing ring 201 can comprise a material that dissolves after contact with liquids such as water. In certain embodiments, a backing ring 201 can comprise a material that dissolves when it contacts water and a dissolving backing ring 201 can be positioned on a main line liner 103 with a hydrophilic material, so that after backing ring 201 dissolves, hydrophilic material is left in place at a juncture.

In certain embodiments, backing ring 201 can comprise a felt material such as a needled felt. Backing ring 201 may comprise a felt material, a needled felt material, a knit material, a polyester, a glass material, a fiberglass material, and mixtures thereof. In certain embodiments, backing ring 201 material may comprise a felt layer that may comprise a felt material comprising a fiberglass. In certain embodiments, backing ring 201 may comprise a membrane. In certain embodiments, backing ring 201 may comprise a water-permeable material. In certain embodiments, backing ring 201 may comprise a water-impermeable material.

In certain embodiments, hydrophilic material 207 can be positioned in pocket 206 of backing ring 201. Placing hydrophilic material in this positioning can allow water that has entered into a leaking pipe to interact with the hydrophilic material, causing it to swell and create a seal in the damaged pipeline.

In certain embodiments, hydrophilic material 207 can be positioned on CIPP liner 102 without backing ring 201. In certain embodiments, hydrophilic material 207 can be positioned at, near, or around liner opening 116 without backing ring 201.

In certain embodiments, backing ring 201 can be positioned so that water may directly interact with a hydrophilic material 207 positioned in backing ring pocket 206. In certain embodiments, backing ring 201 can be made of a water permeable material so that water may pass through backing ring 201 and interact with hydrophilic material 207 positioned in backing ring pocket 206. By positioning hydrophilic material 207 in backing ring pocket 206, hydrophilic material 207 remains in place and is not removed, altered, or wiped away when CIPP liner 102 is being positioned in a pipe line. The devices and methods described herein thus provide the unexpectedly superior results of forming a better seal at a pipe juncture. Positioning hydrophilic material 207 in backing ring pocket 206 also provides the unexpectedly superior results of being sized so that the optimal amount of hydrophilic material 207 is positioned at juncture 117. In some embodiments, backing ring 201 can form a useful pocket 206 for delivering hydrophilic material to a juncture 117.

Backing ring 201 can be positioned on main line liner 103 so that it will be at or around the juncture 117 after CIPP lateral liner 104 is inverted into lateral pipe line 114. Backing ring 201 can be bonded to main line liner 103. Bonding can be done via heat, resins, adhesives, stitching, epoxies, glue, tape, or the like.

Backing ring 201 can have an outer diameter of about 3 inches to about 14 inches and distances there between. Backing ring 201 may comprise an outer diameter of about 3-5 inches, 5-7 inches, 7-9 inches, 9-12 inches, 12-14 inches, 5-10 inches, and ranges therebetween, along with metric equivalents or approximations.

A main pipe line can have a diameter between about 4-6 inches, about 4-8 inches, about 4-12 inches, about 6-12 inches, about 8-10 inches, about 8-12 inches, about 12-24 inches, about 12-48 inches, greater than about 48 inches, and ranges therebetween. A lateral pipe line can be 4-6 inches, about 4-8 inches, about 4-12 inches, about 6-12 inches, about 8-10 inches, about 8-12 inches, about 12-24 inches, about 12-48 inches, greater than about 48 inches, and ranges therebetween, along with common metric equivalents or approximations.

Backing ring 201 can have an inner diameter of about 1.5 inches to about 8 inches and distances there between. Backing ring 201 may comprise an inner diameter of about 1.5-3 inches, 3-5 inches, 5-7 inches, 5-8 inches, 3-7 inches, 3.5-5 inches, and ranges therebetween, along with metric equivalents or approximations.

In certain embodiments, backing ring 201 is circular in shape. In certain embodiments, backing ring 201 is ovular in shape. In certain embodiments, backing ring 201 comprises an outer diameter having a circular shape and comprises an inner diameter having an ovular shape. In certain embodiments, backing ring 201 is configured to be used with a T-shaped liner assembly. In certain embodiments, backing ring 201 is configured for use with a Y-shaped liner assembly.

In certain embodiments, the CIPP liner assemblies as described herein can comprise a T-shaped or a Y-shaped CIPP liner.

Backing ring 201 can help strengthen CIPP liner 102 at the area around where main line liner 103 and CIPP lateral liner 104 are joined. Backing ring 201 can also help strengthen CIPP liner 102 at juncture 117 once CIPP liner 102 has been cured By strengthening CIPP liner 102, hydrophilic material 207 can be more effectively positioned in this area. Backing ring 201 can stabilize lateral opening 115 so that, during inversion, CIPP lateral liner 104 is more likely to be properly inserted into lateral pipe line 114. By incorporating a backing ring as disclosed herein, these unexpectedly superior results can be achieved.

As used herein, the term CIPP liner can mean a main line liner, a CIPP lateral liner, or the combination of these. The meaning of these terms will be clear to the skilled artisan when viewed in context.

As used herein, the term membrane can mean a membrane, a main line liner membrane, a CIPP lateral liner membrane, or the combination of these. The meaning of these terms will be clear to the skilled artisan when viewed in context.

As used herein, the term bladder can mean a main liner bladder, a lateral installation bladder, an inflation bladder, a calibration hose, or the combination of these. The meaning of these terms will be clear to the skilled artisan when viewed in context.

As used herein, the terms "invert" (and its other tenses) may be used interchangeably with "evert" (and its other tenses) depending on the perspective of that which is being described (e.g., inverting or everting a liner) and the meaning of these terms will be clear to the skilled artisan when viewed in context.

Although the foregoing description is directed to the preferred embodiments of the invention, it is noted that other variations and modifications will be apparent to those skilled in the art, and may be made without departing from the spirit or scope of the invention. Moreover, features described in connection with one embodiment of the invention may be used in conjunction with other embodiments, even if not explicitly stated above.

What is claimed is:

1. An apparatus comprising a main line liner, a cured-in-place pipe (CIPP) lateral liner, and a backing ring positioned on the main line liner;

wherein the backing ring comprises:

an outward-facing edge portion around an outer circumference of the backing ring;

an inward-facing edge portion around an inner circumference of the backing ring;

a bonded portion; and

an unbonded portion;

wherein the bonded portion is attached to the main line liner; and

wherein the unbonded portion defines a pocket between the unbonded portion and the main line liner, and the pocket is adapted to hold a material.

2. The apparatus of claim **1**, wherein the CIPP lateral liner is impregnated with a resin.

3. The apparatus of claim **2**, wherein the resin is a polyester or a vinyl ester.

4. The apparatus of claim **1**, wherein the material is a hydrophilic material.

5. The apparatus of claim **1**, wherein the material is a hydrophobic material.

6. The apparatus of claim **5**, wherein the hydrophobic material is selected from the group consisting of a wax, a hydrophobic rubber, a hydrophobic paste, a hydrophobic gel, and any combination thereof.

7. The apparatus of claim **1**, wherein the bonded portion defines a bonded surface area, and the bonded surface area is about 5% to about 90%.

8. The apparatus of claim **1**, wherein the unbonded portion defines an unbonded surface area, and the unbonded surface area is about 1% to about 80%.

9. The apparatus of claim **1**, wherein the backing ring defines an inner diameter, and the inner diameter is less than or equal to a diameter of a lateral opening on the CIPP lateral liner.

10. The apparatus of claim **1**, wherein the backing ring is saturated with a resin.

11. The apparatus of claim **1**, wherein the backing ring is made of a material selected from the group consisting of a felt material, a needled felt material, a knit material, a polyester material, a glass material, a fiberglass material, and any combination thereof.

12. The apparatus of claim **1**, wherein the bonded portion of the backing ring is bonded to the main line liner via heat, resins, adhesives, stitching, glue, or tape.

13. The apparatus of claim **1**, wherein the inner circumference of the backing ring is circular.

14. The apparatus of claim **1**, wherein the outer circumference of the backing ring is ovular.

15. The apparatus of claim **1**, wherein the main line liner and the CIPP lateral liner are a single continuous material, such that when the apparatus is provided in a pipeline containing a main pipeline and a lateral junction pipeline, a portion of the main line liner contacts a portion of the main pipeline and a portion of the CIPP lateral liner contacts a portion of the lateral junction pipeline.

16. The apparatus of claim **15**, wherein the inward-facing edge portion of the backing ring contacts the CIPP lateral liner.

17. The apparatus of claim **1**, wherein the main line liner comprises a membrane layer and a felt layer.

18. The apparatus of claim **17**, wherein the CIPP lateral liner comprises a membrane layer and a felt layer.

19. The apparatus of claim **18**, wherein the main line liner and the CIPP lateral liner are a single continuous material, such that when the apparatus is provided in a pipeline containing a main pipeline and a lateral junction pipeline, a portion of the felt layer of the main line liner contacts a portion of the main pipeline and a portion of the felt layer of the CIPP lateral liner contacts a portion of the lateral junction pipeline.

20. The apparatus of claim **19**, wherein the inward-facing edge portion of the backing ring contacts the felt layer of the CIPP lateral liner.

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